ENGINEERING AND SCIENCE

MONTHLY

JUNE • 1946

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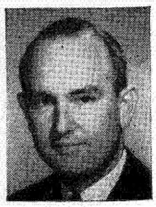
BY-LINES

L. P. SPALDING



L. P. Spalding received his B.S. degree in chemistry from the California Institute of Technology in 1936. After graduation he was employed by the Kinney Iron Works for two and one-half years, joining North American Aviation, Inc., in 1939. Starting as a chemist and metallurgist in the development laboratory, Mr. Spalding advanced to the position of chief research engineer, which he has held since 1942.

. . .

DR. WALDO E. FISHER

Dr. Waldo E. Fisher received his Ph.D. from the University of Pennsylvania, and at present is professor of industrial relations, and research associate, at the Wharton School of Finance and Commerce. He was formerly a member of the staff of the International Labor Office, chairman of the Industrial Relations Committee of the Philadelphia Chamber of Commerce, chairman of the War Manpower Council (Philadelphia-Camden area), and consultant to the National War Labor Board. Because of his extensive research in economics and industrial relations, Dr. Fisher was selected as consultant to a special committee formed by the American Institute of Electrical Engineers to study collective bargaining by engineers.

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COVER CAPTION:

The ancient art of glass blowing attains its highest modern peak in the precision handling of complex electronic tubes. Leigh Harris, an expert glass craftsman for thirty years, is shown fabricating a maze of glass parts. Custom-made tubes take as long as two months to complete.

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ENGINEERING AND SCIENCE
Monthly

The Truth Shall Make You Free

CONTENTS FOR JUNE, 1946

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ENGINEERING AND SCIENCE MONTHLY

Edited at California Institute of Technology

on and off **The Main Line**

JUNE, 1946

This begins a monthly page of travel news gleaned from Southern Pacific's 15,000 miles of line and beyond. We're going to try to make these pages honest, helpful and informative. We will report to you news about our railroad, what we're doing for your comfort in case you decide to "try the train," interesting places to visit, and perhaps we'll tell an occasional human interest story about the 90,000 men and women who are the Southern Pacific.

If you have any ideas about increasing this page's service to its readers, please write me at Room 735, 65 Market Street, San Francisco 5, California.

½ DAY FASTER

Starting June 2, we will cut approximately *a half day* from the running time of our *Overland Limited* and *Golden State Limited*. The *Overland* will run from San Francisco to Chicago in $48\frac{1}{2}$ hours and will go over the High Sierra by daylight in both directions. The *Golden State* will run from Los Angeles to Chicago in 48 hours. This is the first time in history that such fast schedules have been offered without extra fare.

Both of these trains will be fully streamlined as new equipment can be obtained. Their cars have been completely refurbished in our shops and are handsomer than ever. Most of the Pullmans on these trains are streamlined now.

The *Overland* has through Pullmans to New York now.

The *Golden State* will also have them starting June 2.

The *Sunset Limited*, never before noted for its speed, will roll from Los Angeles to New Orleans in $49\frac{3}{4}$ hours.

HOTEL PLAYA DE CORTÉS

Originally built by Southern Pacific, Hotel Playa de Cortés at Guaymas, Mexico, is now being operated by Ernest Byfield of Hotel Sherman in Chicago and Louis L. Larrea of Chicago's famous Ambassador East and West.

The new management reports that Playa de Cortés will be open for the first time in July, August and September. The hotel is booked solid until June 15th, but reservations are still available for the summer months. The thermometer during these months occasionally hits 100°, but the humidity at this "Desert Resort by the Sea" is so low that the heat is not uncomfortable.

The main thing is that marlin and sailfish are caught in the summer months. These kings of sport fish are more plentiful in the waters near Guaymas than anywhere else in the world.

To get to Hotel Playa de Cortés, take Southern Pacific to Tucson, local train to Nogales, thence a Southern Pacific of Mexico train to Guaymas.

Any S.P. agent will gladly make train arrangements for you. For hotel information write Howard G. Mayer & Associates, 6331 Hollywood Blvd., Hollywood, Calif.

"BEAVER" BACK

Before the war, we inaugurated an economy train between Portland and San Francisco called the *Beaver*, for chair car and tourist sleeping car passengers exclusively.

Now this popular train is back with a much faster schedule. Reasonably priced meals in the diner. Lounge car for tourist sleeping car passengers.

The fare between Portland and San Francisco in chair cars on the *Beaver* is only $12.40 one way, $22.30 round trip. In tourist sleeping cars the fare is $18.38 one way, $27.60 round trip (upper berth $3.25 each way, lower $4.30). Plus the 15% Federal tax that applies to all forms of transportation.

The *Beaver* leaves Portland daily at 5 p.m., arrives San Francisco 11:50 a.m., connecting with the streamlined *Noon Coast Daylight* to Los Angeles. Similar schedule northbound.

THE SEVENTH MILLION

With the return of the *Noon Daylight*, Southern Pacific now offers you a choice of three *Daylights* daily in each direction between San Francisco and Los Angeles—two via the Coast and one via the San Joaquin Valley.

The return of the *Noon Daylight* highlights the fact that Southern Pacific's red-and-orange streamliners have carried more than *seven million passengers* since they were first placed in service. There isn't another set of trains in the country that can touch that record.

We thought you would like to know that the West, which has the biggest and best of everything else, has the most popular trains, too.

ATTENTION, MOTHERS

If you have to travel between San Francisco and Los Angeles with small children, the *Daylights* are a pretty good solution. Children under 5 ride free, from 5 to and including 11, half fare. Furthermore, your children get reserved seats just like you, even if they ride free. Also there's a maid on board to help you warm the baby's formula, etc.

The fare between San Francisco and Los Angeles in chair cars on the *Daylights* is only $6.60 one way and $11.90 round trip (plus Federal tax).

WANT A TRAIN PRIMER?

For the San Francisco World's Fair (seems a long time ago, doesn't it?) we published a little 16-page *Train Primer*, which told how to tell our locomotives apart, what our signs, signals and whistles mean, etc. Quite a fascinating little book, if you like trains. We have a supply of these booklets left. If you want one, free, write Room 735, 65 Market St., San Francisco 5, Calif.

—H. K. Reynolds

S·P *The friendly Southern Pacific*

ENGINEERING AND SCIENCE
Monthly

Vol. IX, No. 6 June 1946

The Month in Focus

SEVERAL items of Caltech news, recently released, may have more significance than is apparent at first glance. They are, the unveiling of the war record of the jet propulsion laboratories, the award to Dr. Linus Pauling of the Willard Gibbs medal of chemistry, and the announcement from Dr. Theodore von Karman of the building of a model of the world's first hypersonic wind tunnel.

Mankind has progressed through various stages of development in his endeavor to be monarch of all he surveys. He has tried to fulfill his desires by means of individual conquest, and has failed. As Charles Morgan, in his book, *Reflections in a Mirror*, points out, even by the close of the Renaissance men of genius in that age were compelled to admit that knowledge had outgrown man's power to assimilate it. More recently, man has tried to achieve supremacy by specialization. In a measure, he has been successful, as the results of World War II testify, but he has also created confusion and indecision among his contemporaries, who have been bombarded on all sides by attacks of seemingly unrelated knowledge.

Sane men, endowed with a reasonable amount of intelligence, refuse to believe, however, that there is not a solution to the chaos with which the world seems confronted today. They likewise refuse to concede that the world will be consumed by the evil which inevitably accompanies every promised good—as, for example, atomic energy. Undaunted by those who seem certain an impasse has been reached, they continue their search for the right road.

PATTERN OF INTEGRATION

The work of the jet propulsion laboratories of the Guggenheim laboratory is more than an unveiling of a part of the Institute's war record. It is the story of research, undertaken in cooperation with the military, which produced results directly instrumental in achieving victory, and leading to peacetime applications of benefit to civilization. In the words of General Eisenhower, "The military effort required for victory threw upon the Army an unprecedented range of responsibilities, many of which were effectively discharged only through the invaluable assistance supplied by our cumulative resources in the natural and social sciences and the talent and experience furnished by management and labor. The armed forces could not have won the war alone. Scientists and business men contributed techniques and weapons which enabled us to outwit and overwhelm the enemy. Their understanding of the Army's needs made possible the highest degree of cooperation. This pattern of integration must be translated into a peacetime counterpart which will not merely familiarize the Army with the progress made in science and industry, but draw into our planning for national security all the civilian resources which can contribute to the defense of the country."

BASIC RESEARCH

If the work of the jet propulsion laboratories at Caltech reveal the possibilities of practical integration of scientific knowledge for the betterment of civilization, the award of the Willard Gibbs medal of the Chicago Section of the American Chemical Society to Dr. Linus Pauling, director of the Gates and Crellin Laboratories of Chemistry at C.I.T., is indicative of the unfailing importance of the advancement of pure science, regardless of its practical applications. "The further progress of industrial development would eventually stagnate," wrote Dr. Vannevar Bush in his book, *Science the Endless Frontier*, "if basic research were long neglected." Dr. Pauling is considered one of the world's leading chemists. The 1946 Willard Gibbs medal went to him in recognition of his research achievements not only in chemistry, but also in physics and biology. It is the second distinction to be conferred upon Dr. Pauling by fellow chemists this year. He was chosen by the Rochester Section of the American Chemical Society last February to present the first Harrison Howe Lecture, established as a memorial to the late Dr. Harrison E. Howe, editor, author and lecturer who helped found that section.

DESIGN FOR THE FUTURE

The announcement of the development of the small scale model of the new hypersonic wind tunnel, and authority granted C.I.T. to build a $150,000 addition to the Guggenheim laboratory, are indicative of the continuing cooperation with industry and government for community and scientific service, undertaken by Caltech during the war years. The hypersonic wind tunnel, when fully developed, will provide data in a completely unexplored range of air speeds. Such information is of paramount military importance in the development of extremely high speed aircraft and military rockets and guided missiles. A few supersonic wind tunnels generat-

(Continued on Page 17)

A Refrigerated Altitude Chamber for Aircraft Testing

By L. P. SPALDING

THE urgent need for improvement in aircraft design and performance which wartime requirements imposed on industry promoted the acquisition of many new facilities for research and testing. Early in the war, North American Aviation built its own wind tunnel, and subsequently it has participated in the Southern California Cooperative Wind Tunnel program which was described in a previous issue of *Engineering and Science*.[1] During 1944, in furtherance of its policy of technical advancement, plans were started by North American for a refrigerated high-altitude testing chamber.

Many design problems have been created by the growing number and complexity of airplane accessories and systems such as cabin pressurization, defrosting, ventilation, heat exchange, and hydraulic equipment, and by the requirements for their satisfactory operation throughout extreme ranges of temperature, pressure, and humidity. There is available only limited experience from which to predict behavior in service. Checking of these items during flight tests of prototype or experimental airplanes is time-consuming and may cost from $500 to $1,500 per hour.[2] Also, when mistakes or malfunctioning are discovered, their correction on the completed airplane involves added expense, production delays, and interruption of essential flight testing. The desirability of proving components and designs at an early stage of development, using laboratory facilities which duplicate the operational environment of the airplane at a cost of $50 per hour, was a major factor in the decision to install an altitude chamber. Consideration was also given to its potential use for physiological work such as pilot indoctrination and checkout for high-altitude flying.

[1] *Engineering and Science*—July, 1945.

[2] See "Flight Test" by Frank Davis—*Engineering and Science*—May, 1946.

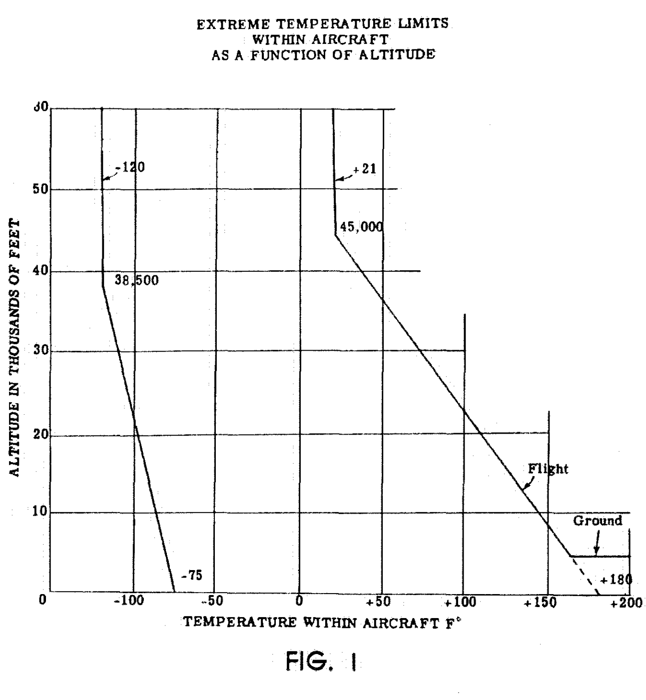


FIG. 1

DESIGN STUDIES AND REQUIREMENTS

Preliminary design plans incorporated reinforced concrete for the main chamber because of existing shortages in steel plate, and indicated savings of $5,000 to $10,000 in cost. However, doubts as to the reliability of concrete for vacuum service with rapid and severe temperature changes, the great difficulty of moving or altering the chamber if this were required at any future time, and a gradual easing of the steel procurement situation, resulted in a final decision to use steel plate construction.

Dimensions of the chamber were dictated by a somewhat arbitrary requirement that it should accommodate the entire fuselage of typical fighter airplanes, or large pressurized sections of bomber or transport types. It was felt that functional test data obtained on an entire system, including observations on the behavior of related systems or accessories, and with all items located and interconnected as in the finished airplane, would be more reliable and significant than tests of individual components. These requirements led to a working section having the form of a horizontal cylinder, 42 feet long and 15½ feet inside diameter (less space for floor and ceiling ducts). Convenient access to the chamber was considered a prime requisite of the design. This necessitated a ground-level interior floor and a quick-opening door of full cross-section size, incorporating a large airlock.

Required rates of climb and dive were evaluated in their fundamental relation to pressure changes, with attention also being given to accompanying temperature changes which might be representative of flight conditions. (See Fig. 1.) A rate of climb of at least 7,500 feet per minute at sea level was established as a compromise between current and predictable airplane performance and the size of evacuating equipment necessary. A second objective was the attainment of an altitude of 50,000 feet in ten minutes. The rate of descent could be set at almost any figure, depending only on the arrangement for admitting outside air to the chamber. An analysis of typical tests to be performed suggested, however, that extremely rapid dives under precise control and with simulation of attendant changes such as temperature rise would not be too important. Accordingly it was decided to design for a 7,500 feet per minute maximum controlled diving rate, with supplementary provisions for rates of the order of 20,000 feet per minute which could be used for special work or in emergencies involving personnel in the chamber.

The ceiling, or maximum attainable pressure altitude, was governed by vacuum pump characteristics and by unavoidable small leaks which occur at packing glands, door seals, and similar locations. In view of the diminishing returns in pressure changes corresponding to increasingly higher altitudes, a limit of 60,000 feet was chosen. This is equivalent to a working pressure of 1.05 pounds per inch or a vacuum of 27.8 inches. In the selection of a vacuum pump for this installation, both rotary and reciprocating types were considered. The former appeared to have some advantages in smoothness of operation, particularly in freedom from pulsation.

On the other hand, some manufacturers of rotary pumps expressed concern over the possible behavior of their liquid seals (oil or water) at the high and low temperatures to be encountered, anticipating either vapor backup or congealing. In general the available rotary pumps were inferior in performance to readily obtainable reciprocating types, while costs ranged from 50 to 200 per cent greater. For these reasons, a decision was made in favor of a reciprocating vacuum pump.

Although the Army Air Forces had established a temperature range of —65°F. to +160°F. as acceptable for the testing and approval of aircraft components, recorded ground and flight observations prompted an extension of these limits to —100°F. and +200°F. A minimum of about —120°F. would be in even better accord with known extremes; however, calculations showed that this could not be attained without added costs for refrigeration which were far out of proportion to any benefits which might be realized. Rates of cooling and heating, commensurate with the established rates of climb and dive, were calculated from data paralleling those used in the construction of Fig. 1.

Humidity control to simulate all degrees of saturation, from desert aridity to fog and rain, and means for the creation of icing conditions with sleet or snow were included in the design specifications for the chamber. This involved provisions for the introduction of water or saturated vapor into the circulating air system of the chamber and supplementary external equipment to provide air under controlled conditions for setups being tested. Aside from humidity control, the supplementary air source is an essential requirement for the testing of cabin air systems, particularly on jet-engined airplanes. In these installations, air for pressurization and heating of the cabin is taken from the engine compressor, possibly at a temperature of 400°F. and a pressure of 25 pounds per square inch. The air may be handled through intercoolers, turbine coolers, and sensitive flow and pressure regulating valves. In simulating operational conditions, compressed air from the factory system was considered unsuitable since it contains water, oil, and dirt, which are difficult to remove—aside from the problem of temperature and humidity control. The several requirements involved suggested an air supply system designed along the following lines. Atmospheric air is drawn through a filter and through refrigeration coils for dust and moisture removal, preheated, compressed by an oil-and-water-free compressor, and delivered to a receiver in which temperature and humidity may be adjusted. Air from the receiver may be supplied either to the chamber or to test equipment in the chamber.

A high rate of air circulation over the heat exchangers was required to effect the desired rapid temperature changes and also to maintain uniformity throughout the chamber when holding fixed conditions. Further specifications for a circulating fan were established by provisions for ducting down from the fan outlet to deliver around 10,000 cubic feet per minute at a reasonable static pressure for such studies as windshield icing and heat exchanger performance. Air velocities of 150 miles per hour over a small area were desired. No attempt was made to duplicate the 300 miles per hour and higher speeds of current airplanes, since this would have entailed major design and equipment changes and carried us into the field of refrigerated wind tunnels. The relative merits of axial flow and centrifugal fans were considered in designing the circulatory system. A centrifugal type was finally selected, since it appeared to be safer from the standpoint of ice accumulation which would lead to clearance difficulties or unbalance. Also, a more convenient and effective installation could be made with this type than with an axial flow fan.

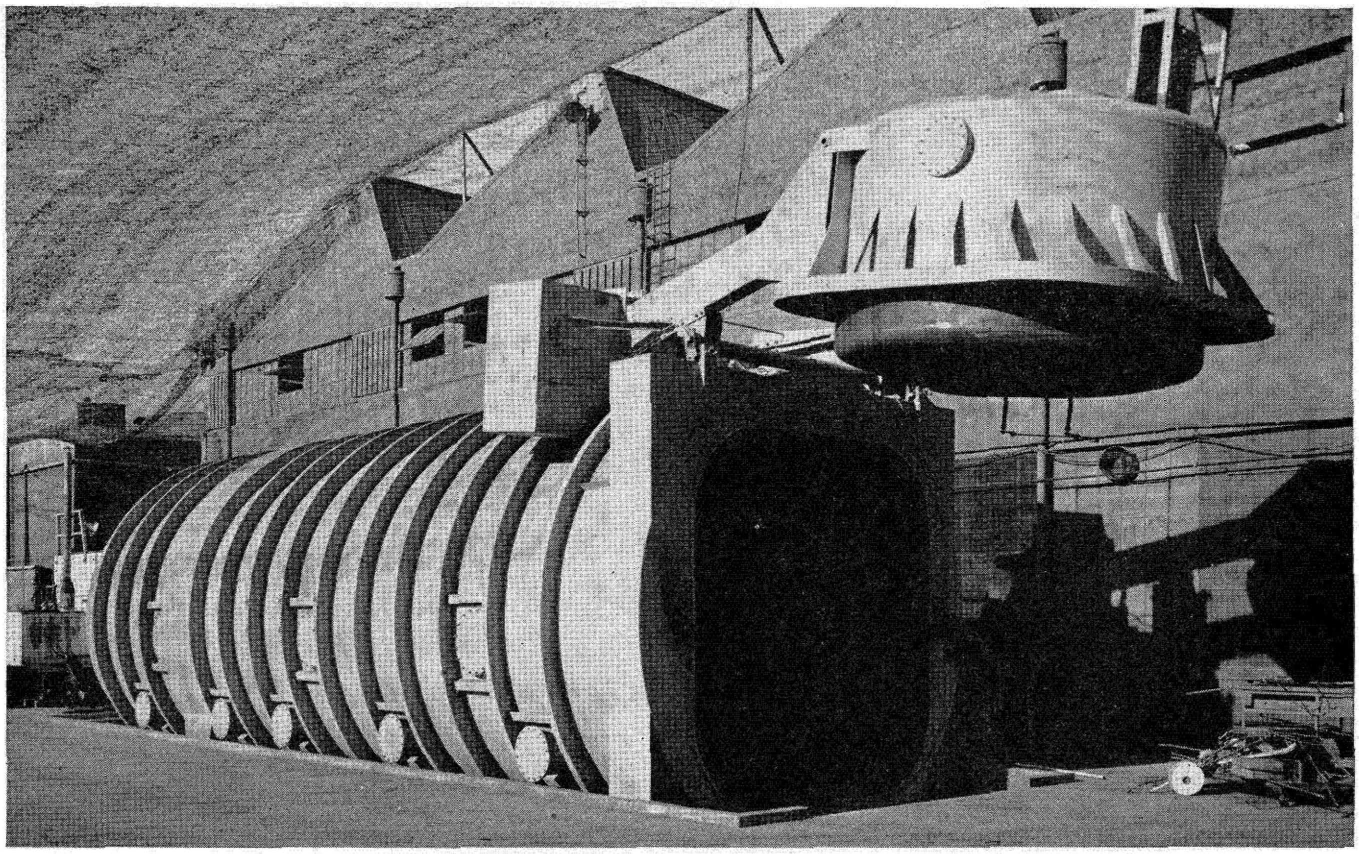


FIG. 2—General view of the chamber shell and door.

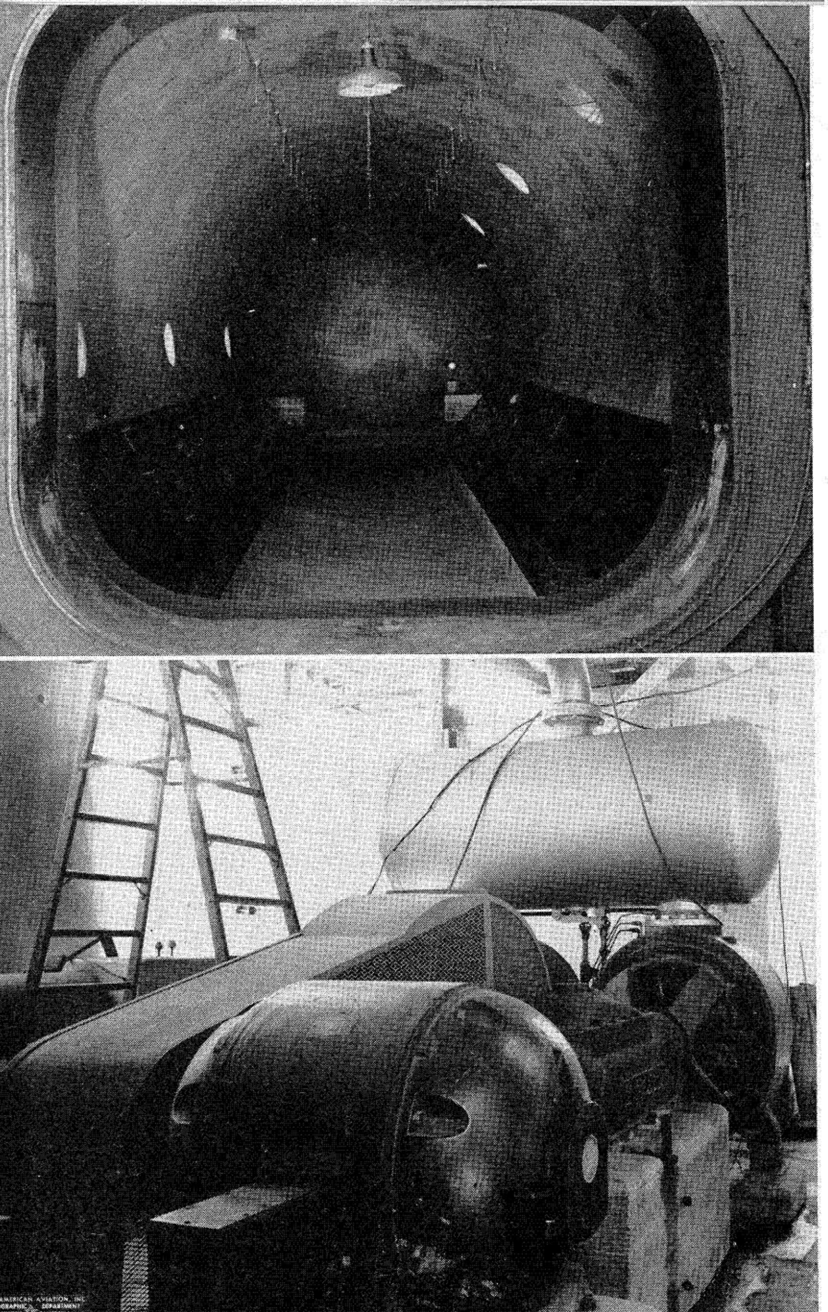


FIG. 3—Chamber interior showing cork lining and floor and fan supports. FIG. 4—Evacuation pump, model drive and receiver. FIG. 5—Fan drive and magnetic clutch.

REFRIGERATION

The relative merits of mechanical refrigeration versus dry ice as a means of cooling were carefully reviewed and several interesting points were brought out. Considerable previous experience had been obtained with equipment utilizing a methyl alcohol-dry ice system in which the chilled alcohol is circulated through conventional heat exchangers. Because of the fact that we had had a more limited experience with very low temperature mechanical refrigeration, a number of installations on smaller altitude chambers throughout the country were studied. The major points considered in analyzing the two methods were: over-all performance, simplicity and reliability of operation, initial cost, and operating cost. Conclusions regarding these items will be briefly summarized.

Systems involving dry ice and a liquid medium (usually methyl alcohol, acetone, or a mixture of the two) have a working low temperature limit of about —100°F., this being fixed by the fluid temperature, which is in the neighborhood of —115°F. A mechanical system can be devised to go as low as this, or even much lower, but it requires several stages, three being ordinarily specified for the temperatures involved in such an installation. Within the limits of the heat exchanger employed, dry ice cooling has the advantage of automatically accommodating itself to the heat load by changes in the rate of consuming dry ice, while the temperature is easily controlled by the fluid circulation pump. In contrast, the mechanical unit is limited in flexibility by the fixed characteristics of its compressors, although this difficulty is partially overcome in multi-stage equipment by the possibility of cutting in successive stages as needed. This lack of flexibility became apparent when calculations showed that a design based on a low limit of —100°F. and a reasonable capacity for heat extraction (say 100,000 B.t.u. per hour at —80°F.) would require several hours to reach —80°F. If the unit were designed to attain —80°F. in thirty minutes it would be greatly oversize and inefficient to operate while being held at some low temperature for a test of long duration. These design problems arise from the necessity of handling large and variable volumes of both liquids and gases through the closed system, which employs a condensable gas for cooling. Correspondingly, in the dry ice method there is some release of CO_2 from the alcohol during its passage through the heat exchanger. However, by the use of an open system the gas coming out of solution is allowed to expand in the return flow and escape from the fluid reservoir to the air. Some studies were made of a semi-closed system in which the CO_2 could be condensed and recovered, but this proved to be uneconomical.

The convenience and reliability of operation with dry ice were strong points in its favor. The only items involved are loading the reservoir with cakes of commercial dry ice, and a trivial amount of upkeep on the small circulating pump. Those familiar with large multi-stage refrigeration installations will appreciate the continuous maintenance involved and the added expense of a qualified stationary engineer to stand by at all times when the equipment is in use. A factor of great importance in the conduct of long tests, costly to re-run, is the chance of equipment failure—negligible in the case of dry ice refrigeration but a very definite possibility with mechanical units.

Cost figures for the two systems were quite surprising. Quotations from the few manufacturers willing to bid indicated an initial investment of about $125,000 for mechanical refrigeration and $10,000 for the dry ice type. Operating cost estimates, based on assumed efficiencies and energy conversions, were 58¢ and $20 per hour, respectively! This would indicate that the mechanical system should soon repay its higher initial cost. However, making reasonable allowances for depreciation, taxes, maintenance, and wages for the stationary engineer for the mechanical refrigeration, it was found that the dry ice system would be cheaper on an annual basis, unless operating time exceeded about 900 hours per year. Furthermore, the operating time would have to exceed about 1,400 hours per year for the mechanical system to pay itself off in its anticipated lifetime. Inasmuch as the estimated operating time was in the neighborhood of 600 hours per year, the economy of dry ice was apparent. This, coupled with the previously mentioned advantages, made dry ice the obvious choice.

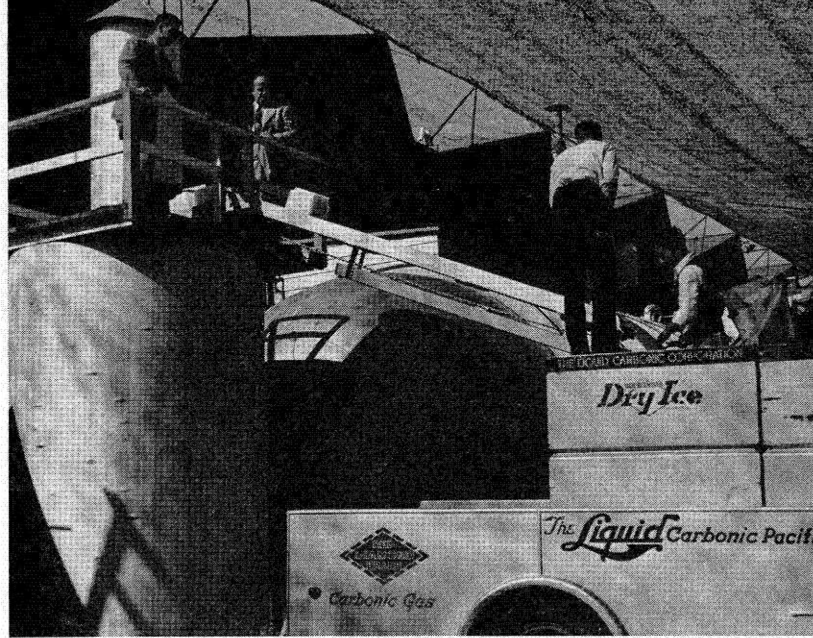
The final important design requirement for the chamber was that all operating equipment and variable conditions should be controlled by automatic recording instruments.

CONSTRUCTION AND BASIC EQUIPMENT

Detail design, construction, and installation of the chamber shell and door, were contracted to the Lacy Manufacturing Company. The shell, fabricated principally of 3/8 inch boiler plate, is 17 feet in diameter and 53 feet in over-all length, including a hemispherical blind end. External stiffening is provided in the form of T-section hoops on 3-foot centers. An additional support encircles the shell between two hoops two-thirds of the distance back from the front open end; this carries two shoulders which are fixed on reinforced concrete pedestal foundations. Similar supports are located at the front end, these being carried on rollers to allow for expansion and contraction of the shell. The entire chamber is set in a concrete lined pit which brings the interior floor to ground level (see Fig. 2).

The main door, approximately twelve feet square with rounded corners, has the form of a box measuring some eight feet from front to back. This section has two smaller doors, one at the front, the other leading into the main chamber, thus forming an airlock for ingress and egress during tests. The door pivots about a point above the front opening and is counterweighted with steel-encased concrete blocks totalling 15 tons. Opening and closing may be accomplished in one minute by means of a 2 horsepower gear-reduced motor. The door seats against rubber sealing strips on the face of the chamber, with no locking required because of a slight overbalance resulting from the pivot location. The outside airlock door seals only against external pressure, while the interconnecting door seals and locks against pressure in either direction. This permits use of the airlock as an independent small altitude chamber (without refrigeration) for physiological work.

An elevated observation catwalk extends along one side of the chamber and leads to the control room, located near the rear end at a slightly higher level. Six viewing ports, 24 inches in diameter, are located, three on one side at eye level above ground, the other three opposite at eye level above the catwalk. Six-pane windows 22 inches in diameter are installed with plastic-impregnated glass cloth retaining rings and impregnated cork gaskets. The pressure pane in each is 5/8 inch thick and the others 1/4 inch, all tempered glass with 1/4 inch spacing. The windows are hermetically sealed with internal desiccant to prevent fogging. Smaller windows are provided in the two doors of the airlock, and there is one in the center of each of the sides at eye level above the ground. Five 18-inch diameter access glands are located on each side of the chamber just above interior floor level. These may be used for mechanical drives,



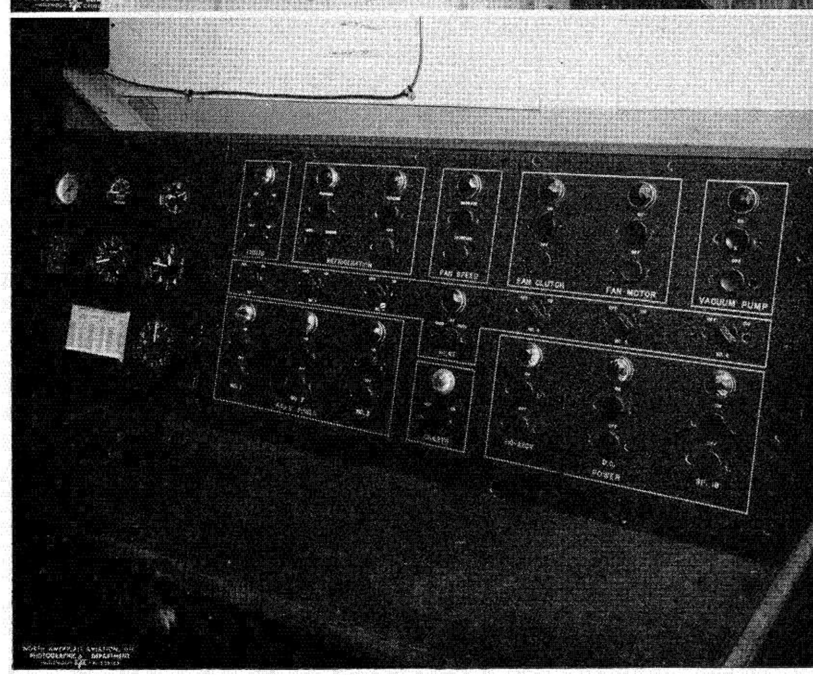


FIG. 6—Charging dry ice into sublimation tank. FIG. 7—Standard air-operated recording temperature and pressure instruments. FIG. 8—Control console.

fluid or power lines, and control or measuring circuits required in the performance of various tests.

The chamber insulation (Fig. 3) consists of a complete 9-inch cork lining in three equal layers of overlapping slabs. The first layer was attached by means of clips and wires, automatic stud-welded to the shell; subsequent layers were wood skewered in place. Each slab was set with a mastic compound developed for sealing pressurized airplane cabins and possessing desirable adhesive qualities over the extreme temperature range to be encountered. The main door has a 9-inch lining on its inner face; the air lock is not insulated. Shoulders of high density cork extend along each side of the chamber for floor supports and the circulating fan is similarly carried on cork pedestals in the hemispherical section at the rear. Replaceable flooring is 2-inch by 12-inch tongue and groove redwood, heavily coated with phenolic varnish. Micarta rubbing strips are installed on mating cork surfaces of the doors and on the cork plugs used to fill those access glands which are not in use. Micarta sheets protect the cork side-walls for a distance of 3 feet up from the floor.

Evacuation equipment includes a duplex, double acting, reciprocating pump with 100 horsepower induction motor and V-belt drive at 277 revolutions per minute (see Fig. 4). The water jacketed cylinders have a 24-inch diameter and 10-inch stroke with 90° opposed cycles, giving a total of four pulsations per revolution and a positive displacement of 2.895 cubic feet per minute. This may be compared with the 8,600 cubic-foot volume of the chamber complete with all interior equipment, but excluding the volume of any test setups. The two vacuum inlets to the pump are manifolded through a small surge tank to an 8-inch line leading from the chamber. A separate 2-inch line connects with the airlock through a section of flexible hose. No difficulties have been experienced with pulsation effects in the chamber, although the original open exhaust was rather objectionable to the ear and caused some vibration in nearby laboratory equipment. Alleviation of this condition by the use of a silencer of the Maxim type was considered, but a simpler solution was reached by exhausting into an underground duct running alongside the pump.

The floor and a plywood "ceiling" form two longitudinal air ducts, each with a cross section of about 9 square feet, and each having an opening just inside the main door. These ducts lead back to a plenum chamber formed by a plywood partition slightly forward of the hemispherical rear section of the main chamber. The fan, located in this section, draws air through the ducts, over upper and lower heat exchangers, and exhausts horizontally through a 34-inch square opening slightly above the center of the partition. Transition ducts may be attached at this point to provide air at higher velocities over small areas, as previously described. The double inlet centrifugal fan is driven by a 150 horsepower induction motor directly coupled to a variable speed magnetic clutch with remote operating control for regulation over a range of 300 to 1,760 revolutions per minute (see Fig. 5). This unit couples to the fan through a floating shaft which enters the chamber wall through a seal of double bellows type. Fan bearings are of the bronze sleeve type, which permits limited axial motion resulting from temperature changes. A thrust bearing is also required to carry the inwardly directed atmospheric pressure loads transmitted by the shaft seal. All bearings, and the seal, run in a special low temperature lubricating oil. The fan is rated at 49,000 cubic feet per minute at 1,165 revolutions per minute and 3-inch static pressure, and 10,000 cubic feet per minute at 1,710 revolutions per minute and 24-inch static pressure; both at 70°F. and atmospheric pressure inlet conditions. Ratings were not available for high altitude or high and low temperature operation.

A sublimation tank, fluid pump, and heat exchangers comprise the refrigeration system. The tank, 5 feet in diameter and 12 feet high, is made of 1/4-inch boiler plate and insulated with 12 inches of cork. Its normal capacity is 700 gallons (alcohol or alcohol-acetone mixture), and 5 tons of dry ice. Fluid is drawn from the bottom by a 7½-horsepower, 450 gallons per minute positive displacement pump, and delivered through a 5-inch line to the two heat exchangers. A return line discharges the fluid in the upper part of the sublimation tank, whence it cascades over the dry ice. The pump and lines are lagged with 5 inches to 8 inches of cork. A motorized conveyor is employed to lift the dry ice blocks to the charging door located in the exhaust stack which surmounts the tank (see Fig. 6).

The heat exchangers, or cooling coils, are mounted above and below the fan. They are each 16 inches deep, 92 inches long, and 45 inches wide, giving a total face area of 47 square feet. Conventional construction is used, with copper tubes and headers, and aluminum fins spaced four per inch. Primary design calculations were based on a required capacity of 500,000 B.t.u. per hour, cooling 3,500 pounds of air per minute from —90°F. to —100°F., with the cooling medium entering the coils at —110°F. and leaving at —105°F. Obviously, much greater cooling rates are attained at higher chamber temperatures when the differential between refrigerant and air temperature is greater. Housed in each heat exchanger are 18 finned Calrod type electrical heating elements. These are connected in six groups, each with a capacity of 36 kilowatts, permitting a stepped heating rate up to 738,000 B.t.u. per hour for heating the chamber or defrosting the coils, when required. In a heating cycle, the refrigerant pump may be reversed to empty the coils of fluid in a few seconds.

CONTROLS AND ACCESSORIES

Operation of all basic equipment is centralized in the control room, which is located above and to one side of the rear of the chamber, and connects with an adjoining general research laboratory. The rearmost upper observation window of the chamber, supplemented by a 180°F. scanning lens, affords a view of test setups or personnel at any location in the chamber.

The Taylor Instrument Companies developed the basic control system, utilizing their standard air-operated recording temperature and pressure instruments, which are panel-mounted above the observation window (see Fig. 7). For the main chamber, provision is made for manual setting of temperature and pressure control points either separately or in conjunction. Provision is also made for automatically increasing or decreasing either or both set points at independently adjustable rates to simulate climbs and dives. A similar system controls pressure in the airlock and is provided with manual and automatic features.

The pressure control instruments operate diaphragm valves in the large and small lines leading from the vacuum pump to the chamber and airlock respectively. Regulation of rate of climb and holding at fixed altitudes are accomplished by this equipment, which also governs dive rates by the controlled admission of air through by-pass valves in the lines. Filtered inlet air may be taken from the atmosphere or from the supplemental conditioned air source described elsewhere. The temperature controller operates the refrigerant pump and heating elements through simple on-off circuits. With this arrangement there is some tendency toward over-riding and hunting. Studies are being made to overcome this defect by proportional input control; for example, by using a variable speed pump or a controlled by-pass in the refrigerant line.

Push-button controls and visual instruments for operating the equipment are grouped in a console (Fig. 8) at the right of the Taylor recording system, with the following items included:

Refrigerant pump—forward, reverse, manual and automatic
Heaters—manual and automatic, 1-6 banks
Fan—motor, clutch, speed control, and tachometer
Vacuum pump
Chamber lighting
Electric circuits to chamber—110, 220, 440 volts AC, 6-28 volts DC, and others
Thermocouples—20-point switch and temperature indicator
Sensitive altimeter
Rate-of-climb indicator
Clock
Oxygen supply and delivery pressures
Recording chart drive

A precision mercury manometer, calibrated in altitude, supplements the altimeter, which is subject to lag and other inaccuracies, and the recording instrument, whose readings cannot be estimated closer than 500 feet.

Additional instrumentation, primarily for the supplementary air source, is contained in another panel facing the control console. Provisions are made for indicating and recording air temperature from the preheater, air temperature and pressure in the receiver following the compressor, and air flow from the receiver to test set-ups in the chamber. Push-button controls for the compressor and heating and refrigerating devices are located in this panel, which also houses chamber humidity indicators and the central equipment for the communication system.

It may be noted that all of the controls described above are for operation of the chamber and accessories. In general, the operator will follow a prearranged schedule for any test run. Through observation of the chamber interior and by communication with other personnel he can satisfactorily carry out this assignment, devoting his attention to safety precautions and other necessary details. Separate facilities are provided for watching and recording the performance of items being tested. A station at ground level opposite the control room utilizes the center observation window of the chamber. The two important permanent installations at this point are a multiple manometer and a multiple point temperature recorder. The manometer has a flat bank of 30 tubes, each with 30-inch scale and usable with positive or negative pressures and various fluids to cover a wide range of measurement. Means are provided for introducing sensitized paper behind the tubes so that all manometer readings can be simultaneously recorded by a single exposure of the paper. The temperature recorder accommodates 140 thermocouples in seven banks of 20 each, with self-contained switching at the rate of one couple every 1.63 seconds, regardless of scale position. Different couple alloys and temperature ranges may be used with the different banks. At present five banks (100 couples) are wired for iron-constantan couples and a range of —150°F. to +800°F., and two banks (40 couples) use a chromel-alumel set for +700°F. to +1,850°F., giving adequate coverage for all contemplated work.

A communication system interconnects the control room and observation station with the chamber and airlock. Combination microphone-speakers are used in the control room and observation stations, with jacks also provided for individual earphones and microphones. Two junction boxes with phone jacks are in the airlock and four sets are spaced along each side of the main chamber, which also has a loud speaker.

The breathing oxygen system, for personnel in the chamber, comprises five aircraft oxygen bottles manifolded together, with lines to eight outlets in the main chamber and two in the airlock. Each outlet has a pressure regulator and instruments: one showing oxygen delivery pressure, the other a blinker signal indicating flow rate. As a matter of convenience in location and use, the oxygen outlets are housed together with the phone jacks in each of the ten junction boxes. Oxygen supply, and delivery pressure at the manifold, are checked by instruments on the main control console.

At the time of writing, details have not been worked out on the means of humidifying air in the chamber and simulating icing of test equipment. Water, saturated vapor, or steam, piped to nozzles at the fan outlet seem to offer the best possibilities, with steam being preferred on account of the lessened tendency to freeze in the inlet line.

To forestall any accidents which might arise during the conduct of tests at elevated temperatures (for example: the operation of combustion type cabin heaters) a fire extinguishing system has been provided. Ten 75-pound CO_2 bottles are manifolded to a distribution system with six outlets in the chamber, each having a conventional fusible plug for automatic release.

The supplementary air system previously referred to draws atmospheric air through a filter and two cooling stages. The first stage, employing a conventional Freon refrigeration unit of approximately two-ton capacity, operates at about +34°F. for removal of a large portion of the moisture. The second stage uses alcohol-dry ice cooling to complete the dehydration at about —65°F. This system was employed because of the greater ease of disposal of the congealed moisture in two increments; and mechanical refrigeration was preferred in the first stage because of simpler temperature control at the desired operating point. Air from the dehydrator is preheated to about 0°F. by an electrical resistance type heat exchanger, from which it is delivered to the compressor inlet. The compressor, with 12-inch bore and 11-inch stroke, has an intake capacity of 305 cubic feet per minute, operating at 300 revolutions per minute from a 60-horsepower, 1,200-revolutions-per-minute induction motor drive. Carbon packing is used in the compressor to eliminate the possibility of oil contamination. Outlet air is delivered to a receiver at 100 pounds per square inch and approximately 250°F., at a rate of 23 pounds per minute. This air may be supplied directly to the chamber or to test set-ups, or it may be further heated in the receiver, to a maximum of 400°F. Both flow and pressure of air from the receiver are controllable.

GENERAL OBSERVATIONS

The inclusion in this article of test data from typical test runs with the chamber was desired; however, this information cannot be made available at present. It may be stated that in all important respects the actual performance of the equipment equals (and in many cases substantially exceeds) the original design requirements. For example, a sea level rate of climb of 10,000 feet per minute has been attained, in comparison with the specified minimum of 7,500 feet per minute. A ceiling of well above 60,000 feet has been reached; the actual figure is in doubt because of the limitations of measuring equipment available at the time. Runs of extended duration have been made at temperatures in the neigh-

(Continued on Page 16)

COLLECTIVE BARGAINING FOR ENGINEERS

By WALDO E. FISHER

THE accompanying address was presented by Dr. Waldo E. Fisher on February 20, 1946, at a dinner-discussion meeting held in the Music Room of the Biltmore Hotel, Los Angeles, under the auspices of the Industrial Relations Section. Dr. Fisher's analysis of this problem supplements two articles published in the March, 1944, issue of Engineering and Science Monthly: "Organization of Engineers for Collective Bargaining" by Franklin Thomas, and "The Engineer in the Labor Picture" by Robert D. Gray.—Editor.

WHY ENGINEERS JOIN LABOR ORGANIZATIONS

COLLECTIVE bargaining for engineers is a recent innovation in the United States. We are not accustomed to thinking of engineers, who have an absorbing interest in scientific knowledge and principles, and who have a strong urge to bring about a more effective utilization of materials, machines, human beings, and natural and mechanical forces, as members of labor unions. Why are engineers and other professional employees joining or forming such organizations?

In answering this question, let us apply the case method and examine two specific situations. In August, 1944, the National Labor Relations Board held an election at two plants of a nationally known company manufacturing electrical equipment. The engineers were given the opportunity to decide whether they desired to be represented by the Federation of Architects, Engineers, Chemists, and Technicians (F.A.E.C.T.), C.I.O., for purposes of collective bargaining. Of the 131 eligible engineers employed in these two plants, 97 participated in the election. Roughly two out of three voted for the F.A.E.C.T.

Why did these engineers designate this C.I.O. affiliate as a bargaining agency? A talk with fifteen of them disclosed the important considerations which led them to take this action. Sometime earlier, the shop employees had signed up with the United Electrical, Radio, and Machine Workers of America, C.I.O. Later, the United Office and Professional Workers of America (U.O.P.W.A.), also a C.I.O. affiliate, appeared on the scene, conducted an organizing campaign, and sought to represent professional as well as office employees. Some of the engineers, afraid that professional employees would be drawn into the U.O.P.W.A., urged engineers to sign up with the F.A.E.C.T. on the grounds that this organization would protect their rights more effectively than the U.O.P.W.A. Many engineers were convinced that membership in F.A.E.C.T. was the best way to forestall membership in the U.O.P.W.A. It was the desire to keep out of a heterogeneous labor organization controlled by non-professional employees that led many of the engineers to vote for the F.A.E.C.T.

Other considerations were also present. Some of the engineers felt that their wages were out of line with those paid shop employees and they were anxious to correct the existing inequities. In several departments, the supervisors in charge, while professionally competent, were arbitrary in their handling of professional employees. The grievances of professional men were frequently neglected while those of the shop employees under the leadership of the United Electrical, Radio, and Machine Workers of America were given prompt attention. Promotions were not always based on merit, and not infrequently engineers with average ability who "played politics" and made it a point to "string along with" their supervisors were pushed ahead of much better men who insisted upon maintaining high engineering standards. Finally, supervisors were sometimes by-passed by management and their recommendations with respect to design and other engineering matters disregarded.

Many of these professional employees now regret their decision. They find themselves out of sympathy with a number of the policies and methods being employed by C.I.O. unions. In their own organization, they are outnumbered by draftsmen and technical employees, who, for the most part, have no professional training and whose interests align them more nearly with clerical and shop workers than with professional employees. They now seek a bargaining unit which will be restricted to professional employees. They have discussed the matter with the Regional Director of the N.L.R.B. and have been informed that any request for a change in the bargaining unit must be supported by very convincing reasons. They are now trying to ascertain what the Board will consider convincing reasons so that they may obtain both a bargaining unit and a bargaining agency that will meet their present desires.

Let us turn to case No. 2. Early in 1944 the F.A.E.C.T., C.I.O., also conducted a campaign to organize the engineers and technical employees in one of the establishments of another large electrical company located in the east. The C.I.O. affiliate succeeded in persuading 20 per cent of the 320 design and development engineers, and 48 per cent of the 470 technical employees to sign cards indicating support of the union. Late in April a group of the engineers got together to discuss the situation; they found that some of them did not want any organization and others did not want to be included in a heterogeneous bargaining unit. A number of them went to the Regional Labor Relations Board to ascertain their rights under the Wagner Act. Early in May they decided to form a Committee for Professional Personnel. This Committee canvassed the professional personnel. It found that many of these men did not want to be included in the same bargaining unit with the technical employees.

The basic reasons for the position taken by these professional men may be summarized as follows: (1) the interests of the two groups are not the same; (2) the work of the engineers is more creative than that of the technical employees; (3) they frequently carry on their work outside of working hours; (4) their work cannot be measured quantitatively; (5) their salaries are substantially higher; (6) they have professional status and take pride in their work; and (7) they are numerically in the minority and can be outvoted by the technical employees. These engineers believed that if they were included in the same bargaining unit they might be committed to action which would conflict with their professional standards and best interests.

A questionnaire was circulated, asking the engineers whether they would like the Committee for Professional Personnel to represent them at the hearings before the board. About two-thirds of the 320 engineers designated the committee to represent their interests, and the committee decided to intervene at the hearings and to present the wishes of the engineers to the board. Even though the committee did not seek recognition as a labor organization, the board permitted it to intervene and to assist in determining the appropriate unit.

An investigation led the board to conclude that the engineers and technical employees could function either as separate bargaining units or as a single unit. It decided, therefore, to postpone its determination of the appropriate bargaining unit until the desires of the employees were expressed under a Globe election. At the election almost two out of three professional employees (64 per cent) voted for a separate bargaining unit.

Sometime after the election, the engineers formed the Association of Professional Engineering Personnel. Later, this association was certified by the board as the result of a consent cross-check determination, and was recognized by the company as the bargaining agency for its professional employees.

What may we conclude from these and several dozen other experiments in collective bargaining on the part of engineers? One important conclusion that may be drawn is that the drive for organization is supplied not so much by engineers as it is by outside labor organizations, or by the fear that such an organization might seek to include professional employees in a bargaining unit for which it might be the exclusive bargaining agent. There is a growing pressure to bring professional employees into heterogeneous unions comprised of professional and technical employees or even clerical employees. Already mentioned are the International Federation of Architects, Engineers, Chemists and Technicians, C.I.O., and the United Office and Professional Workers of America, C.I.O. Reference should also be made to the International Federation of Technical Engineers', Architects' and Draftsmen's Unions, A.F. of L., the United Clerical, Technical and Supervisory Employees Union, affiliated with the United Mine Workers of America, and the American Federation of Office Employees International Council, A.F. of L. Finally, some of the international industrial unions, such as those in the automobile, steel, oil, and electrical industries, are expected to attempt to extend their jurisdiction to include clerical and professional employees.

The movement to organize professional employees is not an American innovation. Physicists, chemists, and engineers, have resorted to collective bargaining in both England and Sweden. In this country the pressure to bring professional and technical workers into labor organizations has been greatly augmented by the existing split in the American labor movement. Both the A.F. of L. and the C.I.O. are anxious through their affiliates to enhance their leadership by expanding their jurisdiction and increasing their membership. Faced with the threat of unionization by an outside agency, engineers frequently seek a bargaining unit and a bargaining agency which they can control and which will serve their best interests as they see them.

Management, however, must not conclude that this is the only important reason that has led engineers to organize. The writer's own study would suggest that a growing minority of engineers is definitely interested in collective bargaining through the medium of strong labor organizations. It is surprising how often from 30 to 36 per cent of the engineers vote for an A.F. of L. or C.I.O. affiliate in an N.L.R.B. election. In Canada, a committee representing fourteen engineering and scientific organizations sent an 8-point questionnaire to the members of these organizations. The committee reported that 92 per cent of those replying were in favor of collective bargaining under a new order in council which would permit engineers a separate bargaining unit and an agency of their own choosing. More significant, however, was the desire of 35 per cent to be included in heterogeneous bargaining units under the then existing order in council if a separate bargaining unit and independent bargaining agencies could not be obtained. The comments of the Burbank Chapter of the Engineers' and Architects' Association, independent, in their brief to the N.L.R.B., are also significant:[1]

The pertinent findings of a recent questionnaire, filled in by 1,145 engineers employed by a very well-known and well-managed manufacturing concern in the east, should be of special interest to employers. One out of five engineers (22 per cent) was planning to leave the company at first opportunity or intended to "shop around" for a new job. One out of four engineers (27.5 per cent) stated that his obligation ended with his normal day's work, or expressed an even less constructive attitude about his obligation to the company. One out of three (31.6 per cent) stated that he was either "generally or extremely dissatisfied with his salary." Three out of four engineers (76.7 per cent) believed that 30 per cent or more of their time was spent doing routine clerical, testing, or other work which a competent semi-technical assistant could handle. Approximately one out of two engineers (47 per cent) stated that he was seldom or never informed on company matters of interest and importance to engineers.

Considerable dissatisfaction was expressed by these engineers with the supervision they received. One out of five (23.1 per cent) stated that his responsibilities were poorly defined. Two out of five (40.7 per cent) believed that their supervisors had little or no concern for increasing the engineers' usefulness to the company or for helping them to get ahead. One out of four (24.8 per cent) considered his division head to be evasive or unreliable in answering questions concerning company policies, salaries, etc., and one out of three (32.0 per cent) stated that his supervisor never let him know where he stood.

Even working conditions were subject to a surprising amount of criticism. One out of five engineers (21.3 per cent) was dissatisfied with the lighting on the job; one out of five (22.1 per cent) with the sanitation; two out of five (43.6 per cent) with the space allotted to them; two out of five (44.2 per cent) with luncheon facilities; one out of two (49.3 per cent) because of the noise on the job; three out of four (75.9 per cent) because of the dirt on the job.

If these findings are at all representative, employers may expect a growing interest on the part of their professional employees in unions and collective bargaining.

STATUS OF THE ENGINEER UNDER THE WAGNER ACT

What is the status of the engineer under the Wagner Act? This query can probably be most effectively dealt with by consideration of a few carefully selected questions.

[1]Quoted in Technologists Stake in the Wagner Act, pp. 142-143.

The graduate engineer with $10,000 invested in university training cannot be happy on $300 a month while he engineers the work for maintenance electricians who average $450 a month with no investment in education. Working Sundays without pay, he supervises engineering projects for which labor is paid double. . . . If the engineer is not to become extinct, the profession will have to seek the protection and benefits of the National Labor Relations Act which is the declared policy of the United States.

1. *Are engineers entitled to the protection of the Wagner Act?*

The Board has ruled that engineers are employees under the Act. They have the right, therefore, to organize and bargain collectively, and management must respect those rights. In support of its ruling, the Board has said that engineers, in common with other employees, have a need for collective bargaining and that this right cannot be denied them because they act in the interest of management and exercise judgment and discretion in their work.[2] There is no reason to believe that the Board will alter its position in the near future.

2. *Must engineers join a union if they do not desire to do so?*

No, they need not join unless they are in a bargaining unit which is represented by a labor organization that has been given a union or closed shop.

To illustrate, let us suppose that the F.A.E.C.T., C.I.O., seeks to represent the professional and technical employees of a given company, that the F.A.E.C.T. requests the board to certify it as the bargaining agency for that group of employees, that the board includes engineers in the bargaining unit, and that the F.A.E.C.T. wins the election. Under these circumstances, engineers would not have to join the union. However, if the employer should later grant the F.A.E.C.T. a union or closed shop, then the engineers would either have to join the union or quit their jobs.

In passing, it may be advisable to distinguish between a bargaining unit and a labor organization. A bargaining unit comprises those classifications of employees that are to be included for purposes of collective bargaining. It may be defined by specifying the classes of jobs or groups of workers to be included in it, or the classes of jobs or groups of workers to be excluded from it. It may be a craft, plant, company, or a subdivision thereof. A labor organization, on the other hand, is "any organization of any kind, or any agency or employee representation committee or plan, in which employees participate and which exists for the purpose, in whole or in part, of dealing with employers concerning grievances, labor disputes, wages, rates of pay, hours of employment, or conditions of work."[3] The board defines the bargaining unit but does not determine the composition of the labor organization. How the organization shall be composed is of no concern to the board, provided the organization keeps itself free of employer domination.

It should be kept in mind that the bargaining unit and the membership of the labor organization need not be coextensive and frequently are not. A labor organization may bargain for all its members or only part of them. In other words, the employees decide upon the scope and composition of their labor organization and the board determines the character of the bargaining unit.

3. *Has the board established a formula for determining an appropriate bargaining unit?*

The board has not established a formula for determining the bargaining unit. It holds that it is its duty under the act to decide "each case on the basis of all the facts and circumstances." While the board has not formulated rigid rules, it has set up a number of criteria which it uses as a guide in the making of a decision. The board attaches "great weight" to two of these criteria: namely, "the relative homogeneity of the unit sought," presumably as reflected by a recognizable identity of interest, similar or closely related skills and functions, common working conditions, and similar factors, and the history of collective bargaining in the plant or industry. The board states that "unless counterbalanced by other elements, bargaining history is often a controlling factor."

The desires of the employees set up a third criterion which is given considerable weight in those situations in which considerations favoring a craft or professional unit and those favoring a more comprehensive unit are substantially the same. In these circumstances, the board applies the Globe doctrine. Under this doctrine, the employees concerned are permitted by secret election to specify whether they want a separate craft or professional unit, or desire to be included in a more comprehensive bargaining unit. It must not be assumed, however, that the wishes of employees are always determinative, because "the board makes its findings of the appropriate unit upon the entire record, including the desires of the employees as reflected by the election results."[4]

4. *If a union or closed shop has not been granted, and the engineers do not join the union, may they negotiate their terms and conditions of employment with their employer on an individual bargaining basis?*

They may not if they have been included in a bargaining unit for which a bargaining agency has been certified. If they have been assigned to such a bargaining unit, their terms and conditions will be negotiated for them by the union, even if as individuals they do not belong.

5. *Has the board shown a willingness to establish bargaining units for professional employees?*

The board has definitely shown a willingness to exclude both professional employees and related technical employees, such as draftsmen, checkers, detailers, tracers, and research assistants of various kinds, from bargaining units of production and maintenance employees, and from units of clerical and office workers. Professional and technical employees have been excluded from heterogeneous bargaining units in well over a dozen cases. There have been exceptions. In at least two of these exceptions, however, the professional or technical employees did not seek a separate bargaining unit.

The board has also shown a disposition to recognize "the appropriateness of units of professional employees." It has permitted engineers to express their desires as to inclusion in a more comprehensive unit in cases involving the Aluminium Company of America, the Lockheed Aircraft Corporation, the General Electric Company, the Radio Corporation of America, and the Shell Development Company. It has refused, however, to recognize "artificial or arbitrary lines of demarcation in determining the scope of the bargaining unit." Bargaining units based purely on the desires of the employees who petition are not appropriate in themselves. In the case of the Curtiss-Wright Corporation and the United Office and Professional Workers of America, C.I.O.,[5] the board would not approve a bargaining unit which classified the company employees as individuals according to whether or not they possess a specified degree of education or experience. In other words, to quote the board, "a unit delineated upon the basis of the scholastic (or equivalent) history of individual employees rather than on the basis of their function would in our opinion be

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[2]See *1 N.L.R.B. 164, Chrysler Corporation,* and *22 N.L.R.B. 1043, Bull Dog Electric Products Company.*

[3]*National Labor Relations Act,* Section 2. (5).

[4]*Ninth Annual Report of the National Labor Relations Board,* 1944, fiscal year, p. 34.

[5]Case No. 9-R-1738, 1945.

unworkable and inappropriate for collective bargaining purposes." It would appear then that job content or function and not education attainments is the primary prerequisite for the determination of a bargaining unit. This is a matter which should be given careful study by both employers and professional employees.

6. What about graduate engineers when they are employed on non-professional work? May they be included in a professional bargaining unit?

In the matter of the Phillips Petroleum Company, the board refused to make a distinction between graduate engineers and other production employees doing the same work. In this case, however, the company desired the inclusion of these graduate engineers in the bargaining unit of production workers. This decision seems to conform with the principle that a bargaining unit must be delineated upon the basis of the functions performed and not the scholastic (or equivalent) history of individual employees.

7. What is the status of engineers in supervisory positions? Do they come under the act?

The N.L.R.B. has been as changeable as a weather vane in its treatment of foremen and supervisors. Recent decisions, however, have shown a high degree of consistency.[6] The board now holds that supervisors come under the act. Its chairman states that they hold a dual role: they are representatives of the employer, and at the same time they are employees. They are, therefore, entitled to the rights granted in Section 7. The board has declared that foremen do constitute an appropriate bargaining unit, and that foremen in all industries subject to the act, regardless of their duties and responsibilities, are entitled to protection under the act.

In the matter of the Jones and Laughlin Steel Corporation, Vesta-Shamopin Coal Division, and the United Clerical, Technical and Supervisory Employees Union, U.M.W. of A., the board ruled that foremen may be represented by an agency which in turn is affiliated with an organization that includes nonsupervisory employees in its membership. As yet the board has not ruled on the question of representation by an agency which also includes rank and file employees in the same locals. The Supreme Court has not had occasion to review recent rulings of the board.

8. This brings us to my last question—Given conditions as they are, including the Wagner Act, what policies and measures may management consider in dealing with its professional employees?

With respect to that phase of industrial relations that has to do with the right to organize and the choice of a union, the employer had better do nothing. The board, in innumerable cases, has declared that "an employer is not permitted to participate in the establishment of a labor organization or its administration nor to contribute to its support." The Act makes action along these lines an unfair labor practice. Steps taken to advise or direct engineers in the exercise of their right to organize may not only prove embarrassing to them, but may act as a boomerang. The employer had better keep hands off. Professional employees would do well to turn to their own professional societies for guidance and assistance. Most of these societies, separately or jointly, are studying the problem. They may be counted upon to assist their members to the extent that they can, under existing legislation.

[6]The decisions relating to the Packard Motor Corporation, the L. A. Young Spring and Wire Company, and the Jones and Laughlin Steel Corporation, Vesta-Shamopin Coal Division.

The employer may be of help in those situations in which a heterogeneous bargaining agency desires to include engineers or professional employees in a bargaining unit with technical employees or non-professional workers. In such a situation, the employer may quite properly insist that the engineers be excluded from the bargaining unit. Such action will give rise to a representation dispute. It will require the board to determine an appropriate bargaining unit, which will take time and give the engineers an opportunity to formulate a course of action. What course of action should be taken is a matter for the engineers to decide. It should be determined on the basis of their personal preference and convictions and the circumstances in which they find themselves.

It would also be helpful if the company would examine its classification of salaried jobs and, where necessary, revise them so that engineers and other professional employees are given job assignments which will enable them to group themselves in a bargaining unit based on the functions performed. Engineers who are assigned to jobs also performed by non-professional employees will find it difficult to win a separate bargaining unit.

There is an area of industrial relations in which the employer can do a great deal. Employers must know that they are faced with competitors who seek the goodwill and loyalty of their professional employees. Engineers, chemists, and physicists, like other employees, have hopes, desires, and wants, that they hope to satisfy. The employer cannot afford to disregard these basic wants. Let us examine some of the more important of them.

Near the top of the list is the pay envelope. Professional employees are deeply concerned with its size, but they also have a genuine interest in the relation of their pay to that of hourly-rated and office employees. The war and post-war wage adjustments have disturbed pre-war wage differentials. Time-and-a-half and double-time frequently have placed the professional employee at a disadvantage. An examination of professional salaries and take-home pay would seem to be much to the point at this time.

Attention to the compensation of professional employees, while important, is not enough. The farther a person moves from the subsistence level, the more important non-financial considerations become.

What are some of the non-financial considerations that have significance for professional people? Important is the desire for recognition and an open road for ability for a chance to get ahead under an organized promotional system based on merit, effort, and service. There is also the desire for efficient, understanding, and impartial supervision, which is always important where human beings are involved, but even more so when professional people are concerned. There is the craving for economic security. The Research Director of the Fortune Survey of Public Opinion states: "The American workman wants first of all security. In using the word, however, I do not mean government sponsored security. The right to work continuously at reasonably good wages would come closest to a definition of the security envisaged. . . . Steady employment is a paramount consideration to ten times as many workers as is high pay."[7] While the emphasis may not be the same, one would expect professional employees to share with shop employees this concern for economic security.

Effective handling of grievances is also an important consideration. Wherever people work in groups, per-

[7]*What American Labor Wants*—American Mercury, February 1944, p. 181.

(Continued on Page 17)

ALLEN LEE LAWS '26

CHARLES W. VARNEY, JR. '22

ALLEN LEE LAWS SUCCEEDS CHARLES VARNEY AS PRESIDENT

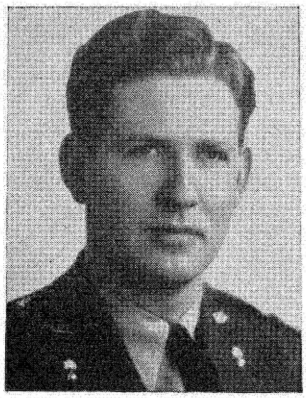
THE C.I.T. Alumni Association has attained its thirty-first birthday, and in entering its thirty-second year, the policies and activities of the organization will be guided by Allen Lee Laws, '26, of the Southern California Edison Company.

Born in New Jersey in 1903, Allen came to California in 1917. He attended Chaffey Union High School in Ontario, California. His choice of C.I.T. as alma mater was conditioned by a combination of an incurable interest in things electrical, and the impassioned salesmanship of a Chaffey Union mathematics professor who argued, with justice, that the Institute had rich rewards to offer her scholars. At Tech, Allen was a member of the "Pharos", an A.I.E.E., and a member of the track team. His connection with the Southern California Edison Company began while he was still an undergraduate; he started work with Edison in June, 1923, as a substitute operator and worked nights until graduation in 1926. After completing Edison's student engineering course he entered the valuation department. From 1929 to 1933 he was engaged in industrial sales for the company. Advancements since that time have made him successively assistant to new business manager in the main office of the company and district manager of the Vernon office. Recently he has been made assistant commercial manager for the Edison Company and has moved his business office from Vernon to the main office of the company in Los Angeles.

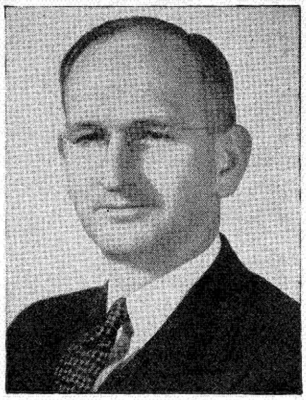
Allen's civic and business activities include membership in the San Marino City Club, the Los Angeles Electric Club, the Pacific Coast Electrical Association, Rotary, and Pharo Fraternity, and work for the San Marino Cub Scouts.

The year that Allen received his degree in Electrical Engineering from the Institute was one in which the editors of the Big T attempted to characterize the members of the senior class with appropriate or semi-appropriate adjectives. The one beneath Allen's senior portrait is "impeccable." Although we are willing to admit that Allen is undoubtedly free from sin or as faultless as most C.I.T. graduates, we feel that the somewhat negative praise of "impeccable" is totally inadequate in describing Allen Laws. We who have worked with him in the Alumni Association admire him for his clear, cool-headed thinking, and his willingness to undertake, organize, and carry through, difficult and thankless tasks. We're sure that during his term as president of the Association, our stature as an association will reach a new high.

In assuming the presidency of the Association, Allen Laws succeeds Charles W. Varney Jr., '22. Chuck Varney had the misfortune, or the good fortune, depending on point of view, to head the Alumni Association in a period when it suffered serious growing pains and the onslaught of inflation. The story of the 1945-46 year rightfully belongs to him, and we hope to have the privilege of printing his annual report in our next issue. In spite of the growing pains within the Association, Chuck Varney's administration was an outstanding success. Interest in the activities of the association was keen and the program well organized and well executed. Fortunately for the Alumni Association, Chuck's service will not end with his retirement from the presidency, as he has been elected to serve for another year on the '46-'47 board of directors and will then become a member of the Past Presidents group.



James R. Bradburn '32



W. M. Jacobs '28

Fred T. Schell '27

Howard B. Lewis '23

At present, Charles Varney is manager of the Alhambra Business Men's Association. He was born in Anaconda, Montana, and was graduated from San Diego High School in 1917. He received his B.S. degree in Engineering and Economics from C.I.T. in 1922, and was with the Southern California Edison Company from 1922 to 1935. He was manager of the Alhambra City Commission from 1942 to 1944. While an undergraduate at C.I.T., Chuck was a member of the Gnome Club and the Press Club. His undergraduate activities included the Tech Staff of which he was successively business manager and editor, advertising manager of the Annual Staff, Board of Control, and, believe it or not, the Mandolin Club.

PRESENTING NEW ALUMNI BOARD MEMBERS

FOUR new members have been elected to serve two-year terms on the board of directors of the C.I.T. Alumni Association. The four whose terms will begin in July, 1946, are: James R. Bradburn, '32, W. M. Jacobs, '28, Fred T. Schell, '27, and Howard B. Lewis, '23. We doubt if any of the new board members need an introduction to the Institute audience but in order to bring history up to date, here is an outline on the four new men who will help guide alumni affairs for the next two years.

James R. Bradburn, '32, prepared for the hectic problems of life in the atomic age by specializing in track, and by making Tau Beta Pi. This same combination of speed and brains won him a host of other undergraduate honors. He was active in the Press Club, the Associated Student Body, the Throopers, A.I.E.E., and in the affairs of Ricketts House. He served on the Exhibit Day Committee in his junior and senior years, and was chairman of the Junior-Senior Prom Committee in his senior year. He was also a member of the track and cross-country teams, as well as of the staff of the Big T and the Tech. The above list explains how he became an Honor Key man, but fails to explain how he had time left over to make Tau Beta. He received his B.S. in Electrical Engineering in '32.

Jim's present position is that of vice president and director of Consolidated Engineering Corporation of Pasadena. He is in charge of Consolidated's commercial engineering department. Prior to joining Consolidated Engineering in November, 1945, he spent five years in the United States Army Ordnance Department, reaching the rank of major. For the last two and one-half years of his Army career, Jim was Chief of the Artillery Division, Rochester Ordnance District. His other business experience included several years with General Electric Company and Eastman Kodak. He also spent two years at the Harvard School of Business Administration, where he received a degree of Master of Business Administration.

W. M. Jacobs, '28, received his B.S. degree in Mechanical Engineering. As an undergraduate, Mort Jacobs was a member of the "Pharos" and vice president of his senior class. He was also active on the Tech staff and in the Throopers, A.S.M.E., Delta Mu Beta, and the Geology Club.

Mort's undergraduate interest in organizations and community service has expanded and continued in his business and social life. He is active in the Pacific Gas Association, of which he has been chairman of the sales and advertising section, and is currently a member of the American Gas Association's promotional committee and national advertising committees. He is also a member of the Los Angeles Athletic Club, Masonic Lodge, Sales Managers Association of Los Angeles, Lions Club, Los Angeles and California State Chamber of Commerce, and president of Rancho Santa Anita Property Owners' Association, Arcadia.

After graduation from C.I.T., Mort did design engineering work in the field of industrial equipment and power plant design for Collins Western Corporation of Los Angeles. In 1930 he entered the Southern California Gas Company where he has been successively industrial service engineer, industrial sales engineer, rate application engineer, and general sales supervisor. At present he is manager of general sales.

Fred T. Schell, '27, varied the pattern of board member undergraduate activity by displaying a marked interest in music. As a member of the Caltech Band and Chorus, he made, we're sure, a harmonious addition to the student body. A harmonious worker as well as musician, Fred was drafted for the Alumni Board because of his excellent work in assisting Allen Laws on the Association Program Committee in 1945-46. At Tech he was a member of Sigma Alpha Pi and Pi Kappa Sigma Military Fraternity.

Upon graduation, Fred entered the employ of the Southern California Edison Company. After completing a preliminary course of training with that company, he was assigned to the industrial sales department and later was employed as assistant commercial engineer in the company's Los Angeles office. In 1939 he again entered industrial sales work until May of 1944, when he was loaned to Columbia University's Division of War Research at New London, Connecticut. While with Columbia University he was assigned to duty with the Bureau of Ships, and engaged in research and engineering work allied with the Navy's submarine program.

Fred returned to Edison as assistant manager of industrial sales after completion of his project at Columbia University in July of 1945. Recently he has been appointed district manager of the Edison Company's Compton district.

Howard B. Lewis, '23, entered C.I.T. in 1918, when the Institute was still the Throop College of Technology. Due to the loss of a term in his junior year with eye difficulties, he received his B.S. degree "in absentia" in 1923. He taught and studied at Cornell the following year and acquired an M.E. degree from Cornell in 1924.

After a year of teaching physics at Riverside High School, he spent six years with Howard Hughes as an experimental engineer, manager of the Hughes Development Company, and general manager and assistant to the president of Multicolor, Ltd., a production laboratory for the processing of colored and black and white motion picture film. These operations were drastically curtailed when the crash came and Howard Lewis found himself out in the cold world in the bottom of the depression. From this unhappy position he started a ten-year program of the development and proof of a philosophy and formula under which an engineer, or group of engineers, could maintain a reasonable degree of independence of action, and obtain and retain a fair proportion of the earnings resulting from the work done.

Work, worry, and luck brought sufficient success and security to justify expansion, and in 1940 Howard Lewis and Glen M. Larson formed the Lewis-Larson Company. They bought a building at 5959 South Hoover Street, Los Angeles, and remodeled and equipped it to serve as offices, laboratories, and experimental shops for twelve to fifteen men. There they gathered a group of men of varied talents able to do justice to almost any problem in the fields of mechanical, electrical, or chemical engineering not involving the expenditure of great blocks of manpower. The efforts of the Lewis-Larson Company have been devoted primarily to the service of the smaller business which needs high grade engineering services, but insufficient quantities of such service to justify maintenance of an adequate engineering staff of its own.

A REFRIGERATED ALTITUDE CHAMBER

(Continued from Page 9)

borhood of —100°F. and +200°F., with gratifying results as to uniformity throughout the chamber and constancy over the time periods involved.

Cost figures for this installation may be of interest to some readers. The basic chamber and operating equipment cost about $60,000, excluding engineering design time. The complete installation, including those accessories (such as the controlled air source) which are required for special tests, and also including design costs, represents an investment of about $75,000. A continuous and substantial backlog of items awaiting tests is convincing evidence of the usefulness of this equipment.

RECEIVES WILLARD GIBBS MEDAL

DR. LINUS C. Pauling, chairman of the California Institute of Technology chemistry division, and noted for his work on molecular structures, will receive the nation's highest award for progress in chemistry, the 35th annual Willard Gibbs Medal of the American Chemical Society, the society announced June 4.

C. I. T. NEWS

SUPERSONIC WIND TUNNEL

CALIFORNIA INSTITUTE OF TECHNOLOGY has just been granted priority approval by the Civilian Production Administration to erect a $150,000 addition to the aeronautics laboratory of the Guggenheim Graduate School. Housing a hypersonic wind tunnel which will be used for studies of projectiles at higher-than-sound speeds, the five-story structure will also contain classrooms for Army and Navy officers training in the special laboratory. Equipment valued at $90,000 will be installed in the building.

It will be recalled that the Cooperative Wind Tunnel has operating conditions to cover speeds up to the velocity of sound. A $2,500,000 project, financed and owned by four southern California aircraft companies—Consolidated Vultee Aircraft Corporation, Douglas Aircraft Company, Inc., Lockheed Aircraft Corporation, and North American Aviation, Inc.—the Cooperative Wind Tunnel is operated by the California Institute of Technology, and dedicated to the development of aeronautical science in war and peace, in the hope that America will always retain her leadership in the air.

ATHLETICS

By H. Z. MUSSELMAN

Director of Physical Education

ALL the spring sport teams, Track, Baseball, Tennis, and Swimming, experienced a very mediocre season, with victories few and far between. No contests in any of the four sports were won from Southern Conference opponents.

In contrast to the past three years, the 1946 teams were composed almost entirely of inexperienced material, most of which was about one year removed from varsity standards. On the whole, the Caltech teams were a little below pre-war standard, while our opponents, finding a greater response from former service men, were somewhat stronger than normal.

Coach Mason Anderson held a six-week spring football practice with thirty-five men reporting. At present, only one letterman from last year's team, Don Hibbard, end, is in school. However, about six lettermen who played on the 1944 and 1945 teams expect to be separated from the Service this summer, and are planning to enroll at the Institute this fall. Their return will greatly brighten the 1946 football outlook.

INVENTOR OF SYNCHOTRON

A NEW atom-smasher called the synchotron three times as powerful as the betatron, the next largest atom-smasher, is scheduled for completion at the University of California early next year, according to an announcement received from that institution.

The synchotron was invented by Dr. Edwin M. McMillan, one of the co-discoverers of neptunium, element 93, used in the manufacture of the atomic bomb. Dr. McMillan received his B. S. degree in 1928 and his M. S. in 1929 from the California Institute of Technology. As an undergraduate at C. I. T., Dr. McMillan took an active part in extra-curricular activities. He was a member of Tau Beta Pi and Sigma Xi, as well as an energetic worker on the Tech staff and the Big-T staff.

Dr. Ernest O. Lawrence, Nobel prize winner and head of the University of California's radiation laboratory, said that the new synchotron is as important a development in atom-smashing as was the cyclotron. With the aid of the new equipment scientists hope to study the fundamental forces which hold matter together. The announcement said that the new atom-smasher may produce energy equal to that of the cosmic rays, which are the most powerful forces yet encountered by science.

The synchotron will accelerate electrons to energies of 300,000,000 electron volts, thus converting them into cosmic rays. At that velocity, Lawrence said, atom smashing "will mount a new threshold."

THE MONTH IN FOCUS

(Continued from Page 3)

ing speed up to four times the velocity of sound now exist, one of them at C.I.T. However, the Caltech experiment is the first involving hypersonic speeds where air velocities up to seven times the speed of sound are produced.

The new president of C.I.T., Dr. Lee DuBridge, who supervised a staff of 3,900 to develop radar during the war, declared on his recent visit to the campus that the most important duty ahead for Caltech and similar institutions is that of supplying the nation with research engineers. Looking toward a future where man will at least have realized some of his cherished dreams of peace and security, Dr. DuBridge said, "The world is not going to disappear in a cloud of atomic dust, nor will an atomic bomb ignite the nitrogen in the atmosphere to give birth to another blazing sun." This danger, often expressed, he declared, has been scientifically disproved. But atomic energy is one million times greater than any form of energy yet known to man, and to determine how intelligently this will be used is the job of the research engineers and the research scientists of England and Russia and the United States, and of all other countries, working together with industries and governments.

Careful integration of all existing specialized knowledge with the avowed purpose of making it best serve the needs of civilization, plus unflagging concentration on basic research, would seem to be the scientific approach to disentangling the confusion and indecision among our contemporaries. For it is only by such a controlled method that we shall be able to avert the inherent dangers of too much specialized knowledge.

COLLECTIVE BARGAINING

(Continued from Page 13)

sonal friction, irritations, and misunderstandings are bound to develop. The professional employee is no exception. Prompt, intelligent, and impartial handling of complaints and grievances is essential to the development of loyalty and morale. Other non-financial considerations include a clear statement of duties and responsibilities as well as the engineering standards that are to be attained, adequate information concerning company policies, programs, and other matters of concern to engineers, working conditions and treatment on the job which measure up with the job's importance and which will buttress the engineers' desire to be regarded as an essential part of management.

In closing, the writer would stress the fact that a majority of American engineers still believe that they can count on management to help them to achieve their basic wants. They still prefer to "go it alone." How long they will continue to feel that way about it depends on a number of factors. Perhaps the most important single factor is management itself. Will management have the foresight to create working relationships which will make for understanding, confidence in each other's honesty of purpose and fair dealing, a will to cooperate, and mutual accommodation when conflicts of interests arise? Such a relationship may not forestall unionization. Engineers may still find it necessary or advisable to establish or join labor organizations. In that event, however, the relationship described above would be no mean asset and should help to make collective bargaining a constructive force within the company.

PERSONALS

IT WILL be helpful if readers will send personal items concerning themselves and others to the Alumni Office. Great interest has been shown in these columns, but more information is required. Do not hesitate to send in facts about yourself, such as change of position or location, present job, technical accomplishments, etc. Please help.

—Editor.

1921

ROBERT CRAIG is now located in Bahama on a field engineering job for the National Supply Co.

1922

JAY J. DE VOE, former Army major, arrived from Okinawa February 8 and was placed on inactive status shortly thereafter. Mr. De Voe has resumed his former position as engineer with the Great American Insurance Co., Los Angeles.

1925

ALBERT J. FERKEL has transferred from The Atlantic Refining Co., Port Arthur, Texas, to the company offices at Philadelphia, Pennsylvania, where he is doing special work on management problems.

EX—'25

HAROLD J. MARTIN was recently appointed city manager of Ontario, California, succeeding Neale Smith '25 who has become city engineer of San Diego, California.

1926

MANLEY W. EDWARDS has returned to his home from active duty as captain in the Signal Corps, having spent the last nine months in Manila with Headquarters Army Forces Western Pacific.

1928

NICHOLAS D'ARCY delivered a paper on hydraulic drives to the American Institute of Mining Engineers on May 9.

1929

LESLIE O. SCOTT, former colonel in the Army Engineers, has returned to his former position with the Southern California Gas Co. as San Joaquin Valley division sales supervisor.

1930

IRA BECHTOLD has just been given charge of all process engineering, in addition to supervising the research department of the Fluor Corp., Los Angeles.

KENNETH L. MILES is now with the central engineering division of the Food Machinery Corp. in San Jose, California.

NELSON NIES is now employed for the County of Los Angeles on the "smog" problem.

1931

JOHN T. SINNETTE, JR. visited his parents in southern California in April. John is employed as physicist with Aircraft Engine Research Laboratory, N. A. C. A., at Cleveland, Ohio.

1932

A. J. TICKNER left the Naval Ordnance Laboratory, Washington, D. C., last December and is now with the Western Electric Co., electrical research products division. Mr. Tickner moved to Pasadena, California.

EDWARD KEACHIE is now employed by the Newberry Electric Corp., Los Angeles.

1933

FRED H. DETMERS has been released from Service after spending fourteen months in Manila and Germany doing photographic work for the Signal Corps.

HARALD OMSTED has accepted a position with J. M. Montgomery in Los Angeles. He assumed his new duties in May.

1934

WILLIAM S. EVERETT has accepted a position as factory representative for Enterprise Engine and Foundry Co., working in

San Francisco, California, until June, and subsequently in the Los Angeles area.

EX—'34

HENRY A. BELLIS, after three years of incarceration as a prisoner of the Japanese in the Philippines, has returned to his pharmaceutical manufacturing business in Manila. Mr. Bellis hopes to return to the States late this year. His wife, a licensed technician, lives in San Francisco, California.

1935

MAJOR O. C. DUNBAR was home in San Bernardino, California, in March on temporary leave. Major Dunbar is in charge of Radio Communications for the European Theatre and is stationed in Frankfurt, Germany. On May 1 he left again for overseas duty.

M/SGT. ROBERT A. McCRAE has been honorably discharged from the Army and intends to return to his own civil engineering business. Bob has served in both European and Asiatic Theatres.

1937

HUGH F. WARNER, now on civilian status, has accepted a position with Wooldridge Mfg. Co., Sunnyvale, California.

WARREN E. FENZI, former ensign, has been released after eighteen months of Service, fourteen of which were spent in the North Pacific area. Warren expects to live in Pasadena, California.

1938

HOMER S. YOUNGS has accepted a new position as director of the shippers' research division of the Air Transport Association of America, Washington, D. C.

SEAMAN FIRST CLASS NICHOLAS IVANOFF visited in southern California in March after honorable discharge from the Navy. Nick was stationed at Great Lakes as an interviewer for Educational Services and also taught air conditioning and Spanish courses.

J. F. DOUGHERTY resigned from Phillips Petroleum Co., Amarillo, Texas, in March to join the staff of DeGolyer & MacNaughton, Consultants, Dallas, Texas, as a geologist.

THOMAS V. DAVIS, who has been working on the atomic bomb project at Los Alamos, left in April for the Pacific area to witness the bomb tests.

CARL FRIEND accepted a position and started to work in March as aerodynamics engineer at Northrup Aircraft Corp., Hawthorne, California. Carl was formerly aerodynamics staff assistant in the private-owner airplane department at Lockheed Aircraft, Burbank, California.

CARL W. AHLROTH has accepted a sales position with Monroe Calculating Machine Co. and spent the month of May in their San Antonio, Texas, division office. Carl was married last November 21.

NED FRISIUS is confined to the St. Vincent's Hospital, Los Angeles, with coccidioides, commonly known as "San Joaquin Valley Fever," a disease which affects the bones. Ned was employed by an oil company in the Valley when the disease was contracted. As recuperation will be a matter of a few months, Ned would be pleased to receive visitors.

1939

WILLIAM M. GREEN began work in April for the Bureau of Reclamation in the Region II Power Office, located in Sacramento, California.

ED SULLIVAN works for the Bureau of Reclamation in Sacramento, California.

WILLARD SNYDER is with the Bureau of Reclamation, the same as Messrs. Green and Sullivan.

A. M. EICHELBERGER, JR. is returning to the States in August to continue his work with the United Geophysical Co. Mr. Eichelberger went to Brazil in April, 1940, to carry on reflection seismograph exploration in search for oil for the Brazilian government. At present, his position is that of party chief. In June, 1943, Mr. Eichelberger married a Brazilian girl and they now have a 16-months-old son.

1940

GILBERT R. VAN DYKE is now employed as a petroleum engineer by the Signal Oil and Gas Co. at Long Beach, California. Gilbert has bought a home in Lakewood Village, Long Beach, California.

GORDON WEIR started to work in April as a meteorologist for the Krick Industrial Weather Service at the Institute.

CHARLES S. PALMER, former captain in the Army Air Corps, is now on inactive status. Captain Palmer was at Wright Field, Dayton, Ohio, during the past year in the control section of the maintenance division.

NORMAN P. OLDSON left May 1 for Bikini as representative of the bureau of ships, Navy Department.

1941

GEORGE A. HARDENBERGH, former captain in the Signal Corps, is now on inactive status. George served twenty-one months in England in an electronics training group, and in the Pacific area about one year as radar officer on enemy equipment intelligence.

GEORGE I. REIMERS, who has served

in the Navy two and one-half years, is now honorably discharged from Service.

CAPTAIN FRANK J. CASSERLY, Marine Corps, visited the campus in April while on leave, having returned from Okinawa where he was Commanding Officer of a Marine Air-Warning Unit (the Marine Corps use of radar during the war). Frank was also with the R. A. F. in England, studying English radar and night fighting tactics. He was married four years ago to Doris Norstad, a former Institute secretary.

LT. GENE L. EDWARDS, stationed on the U. S. S. *Rudyerd Bay* when on active duty, is now on inactive status.

JOSEPH W. LEWIS has been honorably discharged from the Navy and has returned to his former position with the U. S. Steel Products Co. of Los Angeles.

PAUL H. ALLEN, JR. has accepted a position with the Air Conditioning Co. of southern California.

ENSIGN KENNETH H. BEERS is now on inactive status. Kenneth was in radar on the U. S. S. *New Jersey*, which returned recently from Tokyo Bay.

1942

ALVIN R. PIATT accepted a position recently with V. E. Kuster Co. of Long Beach, California. This firm manufactures oil well surveying instruments and does development work for the petroleum industry.

WAYNE MACROSTIE was released from active duty last November and is presently employed by C. G. DeSwarte Structural Engineers of Los Angeles. A son, Steven Wayne, was born to the MacRosties last March 3.

FRANK FLECK accepted a position with Firestone Tire Co. in South Gate, California, in April.

HARRISON PRICE left early in May for Lima, Peru, where he is working as a combination service and sales engineer for Ingersoll-Rand Co.

T. G. ATKINSON is employed by Nate Whitman, engineer of Pasadena, California.

ENSIGN K. H. SADLER who is stationed at San Diego, visited the Campus in April.

LEIGHTON J. TRUE, JR. has accepted a position as product development representative, Oronite Chemical Co., in San Francisco, California.

THOMAS G. ATKINSON, former Navy lieutenant, is now on inactive status. With the Seabees, Tom returned from Okinawa last December to transfer to the Public Works Department, Great Lakes.

LT. (jg) JOSEPH FRAZINI visited the Institute on a 4-day leave in April while his ship, the U. S. S. *New York*, stopped off at San Francisco enroute to Bikini Atoll for the atomic bomb tests.

JOHN A. WIDENMANN is employed by the Federal Radio and Television Co., Los Angeles.

1943

ROLAND SAYE has accepted a position with the Pacific Airmotive Corp., Glendale, California.

EDWARD A. WHEELER is president of the North Shore Broadcasting Co. Inc., which is building a FM commercial broadcasting station, WEAW, in Evanston, Illinois. Mr. Wheeler will manage the station when construction is completed.

DEXTER HAYMOND, a lieutenant in the Signal Corps, is operating a broadcasting station on Leyte.

ROBERT M. FRANCIS, formerly a lieutenant (jg), is now on civilian status. Bob was located in Oregon and Washington in Aviation Ordnance for about three years.

CHARLES STRICKLAND, formerly a lieutenant (jg), has just finished postgraduate work at the U. S. Naval Academy and is now released from Service.

1944

CLIFFORD I. CUMMINGS is the father of a daughter, Carol Lynn, born on February 3. Clifford is a lieutenant in the Army Signal Corp and is, at present, stationed at Mediterranean Theatre Headquarters in Caserta, Italy.

ENSIGN WILLIAM R. HAMILTON is now on inactive status, having returned from the Naval Occupational Forces in Kure, Japan, where he has been stationed for three months. Bill was married a year ago to Miss Helen Matthews of Culver City, California.

LIEUTENANT (jg) WILLIAM BAIR, Engineering Officer on a PCER #850, has returned from Guam. His ship was decommissioned at San Diego. When overseas, he was on weather patrol duty, consisting of air-sea rescue patrols.

ROBERT LAABS accepted a position at North American Aircraft Corp., Inglewood, California.

1945

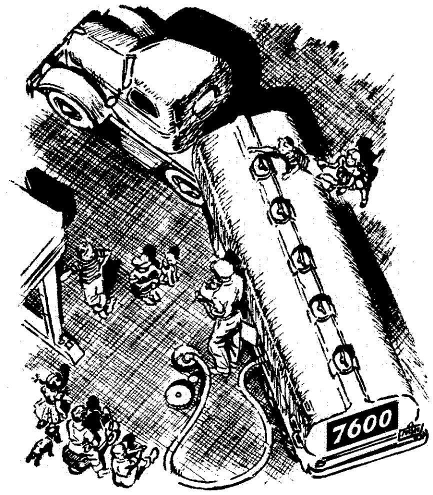
ENSIGN DALE SCARBOROUGH, who is Commissary Officer at the Treasure Island Navy Yard, visited the Campus in April. Dale expects to be placed on inactive status in July.

ENSIGN RICHARD JASPER, Seabees, is now separated from Service, having returned from bases at Okinawa and Honolulu.

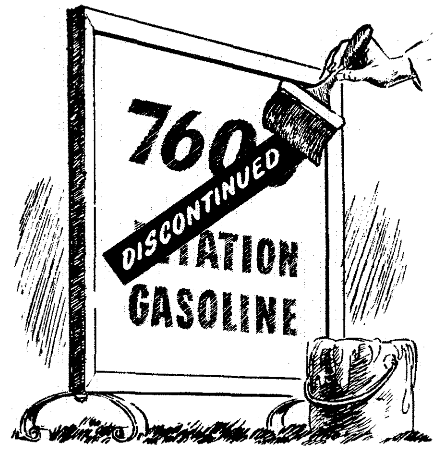
ENSIGN WILLIAM R. BURNS is back on civilian status, having served for the past six months at the San Diego Navy Weather Central.

Maybe you were satisfied—but we weren't

1. Immediately after V-J day military demand for high-quality gasolines fell way off. Consequently most oil companies were able to put out better civilian gasolines than motorists had ever experienced before. This made it pretty easy to satisfy the customers. People were delighted with the new postwar products.



2. Under the circumstances, you'd hardly expect an oil company to come out with a still better gasoline. But less than a month after Union Oil had introduced postwar 76 and 76-*Plus*, we brought out 7600 Aviation Gasoline—a fuel we had been delivering the Armed Forces for use in non-combat aircraft.



3. We introduced 7600 at the same price for which it sold at airports—3½¢ more than Ethyl. It sold like hotcakes. Unfortunately, however, it hadn't been on the market a month before O.P.A. amended its regulations in an attempt to make us sell the product at the prevailing price of Ethyl. Since this was impossible we had to take 7600 off the market.

4. However, that's another story. The important point is this: we made 7600 available *on our own initiative.* The customers didn't demand it. Conditions didn't make it necessary. But we knew that even though the public was more than satisfied with our present gasolines, a still better one would win us customers. And we were in *competition.*

5. If the oil business had been a monopoly – private or governmental – this wouldn't have been the case. For there's no incentive to go after more customers *when you already have them all.* But because we didn't have all the customers, we had a very good reason for introducing an improved product.

6. All of which goes to prove, we think, that the only way you can guarantee *maximum progress* in an industry is to have an economic system that guarantees *maximum incentives.* Our American system, with its *free competition*, provides these to a degree no other system has ever approached.

UNION OIL COMPANY

OF CALIFORNIA

This series, sponsored by the people of Union Oil Company, is dedicated to a discussion of how and why American business functions. We hope you'll feel free to send in any suggestions or criticisms you have to offer. Write: The President, Union Oil Company, Union Oil Bldg., Los Angeles 14, Calif.

AMERICA'S FIFTH FREEDOM IS FREE ENTERPRISE